Apache Spark on HPC clusters

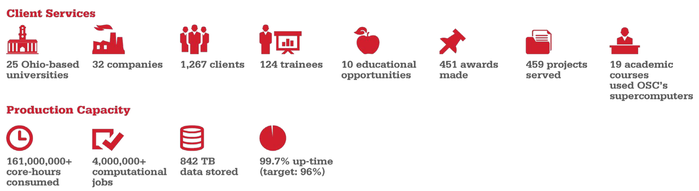
Shameema Oottikkal, Troy Baer, and Douglas Johnson

Ohio Supercomputer Center, 1224 Kinnear Road, Columbus, OH 43212

HPC service at OSC

Ohio Supercomputer Center provides high performance computing, software, storage and support services for Ohio's scientists, faculty, students, businesses and their research partners.

Empowering Clients: Organizational Impact CY2015



OSC Service Catalog

Cluster Computing • High Performance Computing • High Throughput Computing • Data-intensive Computing	Research Data Storage • Project Storage • Archival Storage
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Partner on Proposals • Cyberinfrastructure solutions • Modeling & simulation for industry	Visualization & Virtual Environments • Visualization Services • Virtual environments (DSL)

Supercomputers at OSC

Storage

Home Directory Space

900 TB usable (Disk) (Allocated to each user, 500 GB quota limit)

Scratch – DDN GPFS

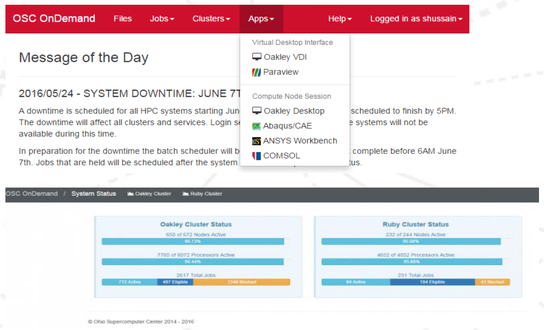
1 PB with 40-50 GB/s peak performance

Project – DDN GPFS

3.4 PB

	Owens (2016)	Ruby (2014)	Oakley (2012)
Theoretical Performance	~750 TF	~144 TF	~154 TF
# Nodes	~820	240	692
# CPU Cores	~23,500	4800	8304
Total Memory	~120 TB	~15.3 TB	~33.4 TB
Memory per Core	>5 GB	3.2 GB	4 GB
Interconnect	EDR IB	FDR/EN IB	QDR IB

Access OSC HPC clusters via ondemand.osc.edu

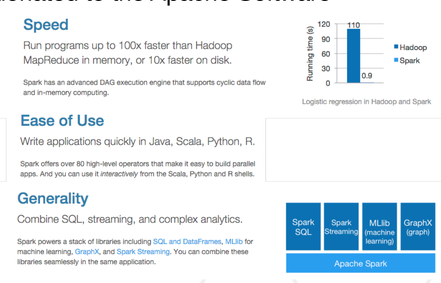


Data Analytics Tools at OSC

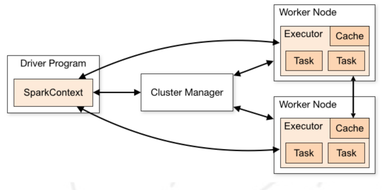
Python: A popular general-purpose, high-level programming language with numerous mathematical and scientific packages available for data analytics.
R: A programming language for statistical and machine learning applications with very strong graphical capabilities.
MATLAB:A full featured data analysis toolkit with many advanced algorithms readily available.
Spark: A framework for running map reduce algorithms in memory.
Intel Compilers: Compilers for generating optimized code for Intel CPUs.
Intel MKL: The Math Kernel Library provides optimized subroutines for common computation tasks such as matrix-matrix calculations.
Statistical software: Octave, Stata, FFTW, ScaLAPACK, MINPACK, sprng2

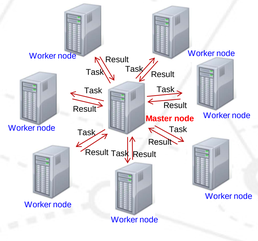
Apache Spark

Apache Spark is an open source cluster computing framework originally developed in the AMPLab at University of California, Berkeley but was later donated to the Apache Software Foundation where it remains today. In contrast to Hadoop's disk-based analytics paradigm, Spark has multi-stage in-memory analytics.



Run Spark Today on OSC clusters





Example Job Submission Script

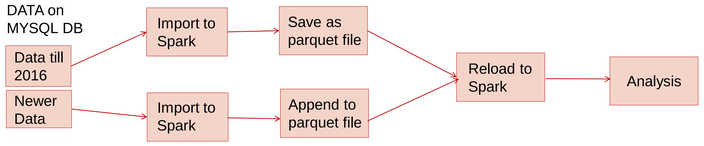
```
#PBS -N spark-statistics
#PBS -l nodes=18:ppn=28
#PBS -l walltime=00:20:00
module load spark
pbs-spark-submit stati.py > stati.log
```

Case study

Data mining of historical jobs records of OSC's clusters

Aim: To understand client utilizations of OSC recourses.
Data: Historical records of every Job that ran on any OSC clusters that includes information's such as number of nodes, software, CPU time and timestamp.

Workflow



Running complex queries on MYSQL DB takes hours of CPU time. We implemented a workflow using Spark that reduces CPU time both for loading and analyzing data from hours to seconds. Bottle neck in the workflow is the process of loading data from MYSQL DB. But once loaded, data is saved as a parquet file to a faster file system which can be accessed in seconds by Spark. Newer data will be loaded periodically to append to the parquet file, such that our internal users can run complex queries faster.

Pyspark code

#importing data

```
df=sqlContext.read.parquet("/fs/scratch/pbsacct/Jobs.parquet")
```

#Which types of queue is mostly used

```
df_mysql.select("jobid",queue").groupBy("queue").count().show()
```

#Which software is used most?

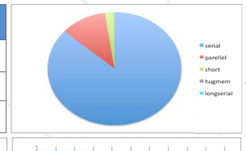
```
from pyspark.sql.functions import coldf_mysql.select("jobid","sw_app").groupBy
("sw_app").count().sort(col("count").desc()) .show()'
```

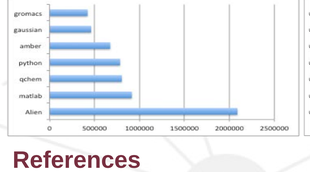
#who uses gaussian software most?

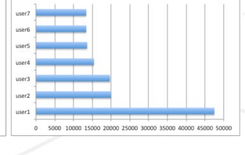
```
df_mysql.registerTempTable("mysql") sqlContext.sql(" SELECT username FROM
mysql WHERE sw_app='gaussian' " ).show()
```

Results

Statistics	MYSQL	SPARK
Job vs CPU	1 hour	5 sec
CPU vs Account	1.25 hour	5 sec
Walltime vs user	1.40 hour	5 sec







References

Visit Ohio Super Computer website: https://www.osc.edu/
OSC OnDemand: https://ondemand.osc.edu/
Available software at OSC: https://www.osc.edu/supercomputing/software
Apache Spark: http://spark.apache.org/
High Performance big data: http://hibd.cse.ohio-state.edu/